

TWO NEW SPECIES OF CALANOIDA FROM A MARINE
CAVE ON MINORCA ISLAND, MEDITERRANEAN SEA:
STEPHOS BALEARENSIS NEW SPECIES (STEPHIDAE) AND
PARACYCLOPIA GITANA NEW SPECIES (PSEUDOCYCLOPIIDAE)

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ABSTRACT

Two new species of calanoid copepods from a marine cave on Minorca (Balearic Islands, western Mediterranean) are described: *Stephos balearensis* new species, and *Paracyclopia gitana* new species. A complete list with all the species of both genera, and the main differences from those most similar are presented.

Rich and diverse biological communities have been found in totally or partially submerged marine caves, and several groups of high taxonomic value have been described. More than 100 species of macroinvertebrates (Sket and Iliffe, 1980), a new class of Crustacea, Remipedia (Yager, 1981; Iliffe et al., 1984), a new order of Peracarida (Bowman and Iliffe, 1985), some new Isopoda and Copepoda, and many other species belonging to several taxonomic groups have been recorded from different marine caves. In the present study two new species of copepods inhabiting a marine cave on Minorca are described.

MATERIAL AND METHODS

Nine females and 24 males of *Stephos balearensis*, and two males of *Paracyclopia gitana* were collected in two different marine caves on Minorca (Balearic Islands, Western Mediterranean). Both caves are placed at the Cap den Font, next to each other (39°49'43"N, 4°12'20"E). The mouth of the Gitano cave is an horizontal fissure at -15 m depth which opens into a high ascending hall. From this room, two branch go upward, surpassing the surface level at the end. Walls are constituted by eroded blocks, while the bottom is of sand and organic detritus. There was not a strong stratification. The mouth of the Sa Gamba cave is a great porch at -14 m depth, with a sandy ascending bottom. After this hall, a narrow horizontal tunnel with a bottom of gravel and boulders leads into an isodiametric well 6 m in height. This well runs into a hall with a bottom of immobile boulders and clear water; part of the walls surpass the 0-m level in a subterranean air room. There is a strong water stratification in summer and overcoat in the well.

Samples were obtained using diving techniques, with a net of mesh size 0.250 mm and square mouth of 900 cm².

All measurements and dissections were made on specimens in lactic acid, following the method used by Humes and Gooding (1964). The length of the body includes the caudal rami but not their setae.

Stephidae Sars, 1902

Stephos T. Scott, 1892

Stephos baleariensis new species

Figure 1A–Q

Material Examined.—Nine adult ♀♀ and 24 adult ♂♂.

HOLOTYPE. Adult ♀ collected at 14 m depth on 19 June 1988 in Sa Gamba cave on Minorca (39°49'43"N, 4°12'20"E). Deposited in the Laboratoire Arago (Banyuls-sur-Mer, France). **PARATYPES**. 8 adult ♀♀ and 24 adult ♂♂ taken at the same locality as the holotype. Two ♂♂ and 2 ♀♀ have been dissected and mounted on slides. All the specimens are deposited in the Laboratoire Arago (Banyuls-sur-Mer, France. Cat. No. 1).

Adult Female.—**BODY**. Total length 0.835–0.849 mm, average 0.840 mm (8 measurements). Prosome about 2.4 times longer than urosome. Prosome: length/width

about 2.14. Head: rounded (in dorsal and lateral view); rostrum absent. Cephalosome and first pediger not fused; fourth and fifth pediger completely fused (Fig. 1A). Urosome: 4-segmented; genital somite with hyaline sheath carrying spermatophore. Spermatophore club-shaped, not so tubular as in *S. lucayensis* (Fig. 1B–C). Furca symmetrical, armed with 4 strong setae around posterior margin and 1 smaller on inner margin (Fig. 1B).

ANTENNULE. 24-segmented, reaches posterior margin of furca (Fig. 1D,D',D'': drawn in three fragments).

ANTENNA. Biramous, exopod longer than endopod (ratio = 1.5). Coxa and basis completely separated, armed with 1 and 2 setae respectively. Endopod 2-segmented: segment 1 with 1 seta, segment 2 with 9 setae on subapical lobe and 7 on apical lobe. Exopod 6-segmented, segment 1 with 1 seta, segment 2 with 3 setae, segments 3 to 5 (very difficult to differentiate each segment) with 1 seta each, segment 6 with 1 marginal and 3 distal setae (Fig. 1E).

MANDIBLE. Distal margin of gnathobase moderately expanded, with 7 cuspidate teeth and one exterior stronger. Palp biramous; basis with 3 inner seta. Endopod 2-segmented, proximal segment with 4 setae, distal segment with 9 setae. Exopod 4-segmented (very difficult to differentiate each segment); segments 1 to 3 each with 1 inner seta, segment 4 with 3 apical setae (Fig. 1F).

MAXILLULE. With precoxa produced into powerful endite bearing 5 stout spines and 5 setae. Coxa with 3 setae on endite; outer lobe (epipodite) represented by 9 setae. Basis fused to endopod, with an outer seta; proximal endite bearing 4 setae; distal endite, incorporated into segment, represented by 5 setae. Fused endopod armed with one group of 5 setae on inner margin; free apical segment with 3 setae. Exopod 1-segmented, with 8 setae along distal and lateral margins (Fig. 1G).

MAXILLA. Small, comprising precoxa, coxa and basis each armed with 2 endites, and a 3-segmented endopod. Both precoxal endites with 3 slender setae. Proximal coxal endite with 3 slender setae; distal coxal endite with 1 stout and three slender setae. Proximal endite of basis powerful, bearing 3 slender setae; distal endite with 1 slender seta. Endopod segments 1 and 2 with no seta; segment 3 with 2 setae (Fig. 1H).

MAXILLIPED. 7-segmented, first segment (syncoxa) armed with a hirsute lobe and 3 groups of setae: proximal group comprising 2 slender setae, middle group with 3 slender setae, and distal group with 4 slender setae. Second segment comprising basis plus almost fused first endopodal segment; armed with 3 setae midway along inner margin and 2 endopodal slender setae distally on margin. Basis also ornamented with a row of stout spinules. Free endopod 5-segmented; first and second segments each with 4 inner setae; third segment with 3 inner setae; fourth segment with 2 inner setae; fifth segment with 3 setae (Fig. 1I).

Swimming legs 1–4 with 3-segmented exopods; leg 1 with 1-segmented endopod, leg 2 with 2-segmented endopod, legs 3 and 4 with 3-segmented endopods (Fig. 1J–O). Spine and seta formula in Table 1. Endopod of first leg with outer margin forming a lobe protruding laterally; inner seta of basis curved to lie in groove distal to lobe (Fig. 1J). Row of long setules present on inner basis margin of leg 1, and on inner coxal margin of legs 2 and 3 (Fig. 1K–L). Other spinule or setule rows as in figures. Fifth leg uniramous and 2-segmented; first segment unarmed with convex inner margin; distal segment with transverse row of spines across middle part, and row of distal spinules, fine setae and strong lateral denticle on distal margin (Fig. 1N–O).

Adult Male.—Total length 0.665–0.761 mm, average 0.73 mm (10 measurements). Male slightly smaller than female and differs only in structure of 5th leg and 5-segmented urosome (Fig. 1P–Q). Fifth legs powerfully developed as grasping

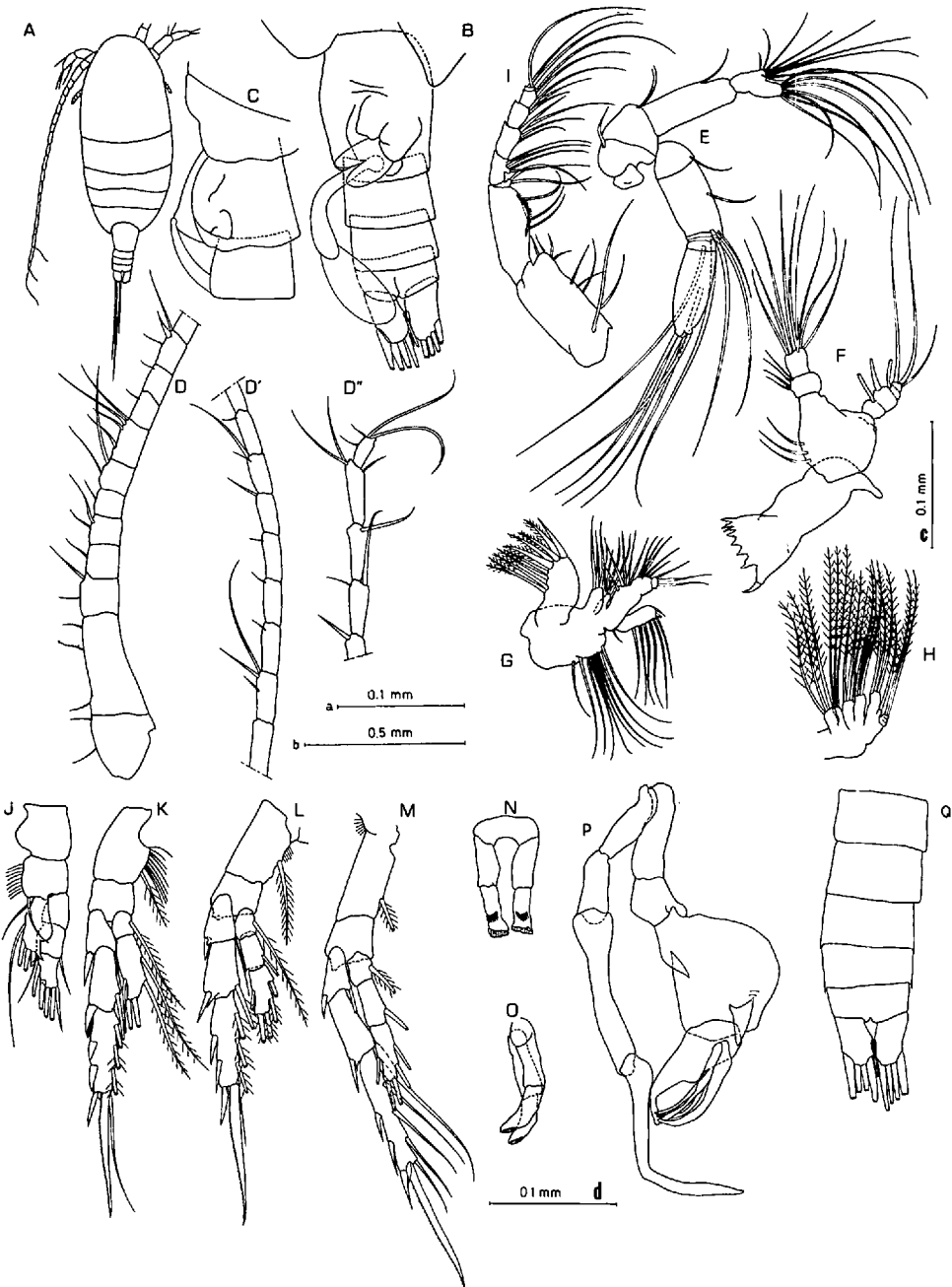


Figure 1. *Stephos balearensis* new species. A–O Female. P–Q male. (A: scale a; B–D'': scale b; E–I: scale c; J–Q: scale d). A. Dorsal view. B. Urosome, ventral view. C. Urosome, lateral view. D–D'–D''. 1st antenna (antennula). E. 2nd antenna (antenna). F. Mandible. G. 1st maxilla (maxillule). H. 2nd maxilla. I. Maxilliped. J. 1st leg. K. 2nd leg. L. 3rd leg. M. 4th leg. N–O. 5th leg. P. 5th leg. Q. urosome, dorsal view.

Table 1. Setation formula of legs 1–4 of *Stephos baleariensis* new species (Stephidae) and *Paracyclopia gitana* new species (Paracyclopiidae) (Arabic numerals represent setae and roman numerals spines)

Leg	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
<i>Paracyclopia gitana</i>								
P1	0-0	0-0	I-0; I-1; I-2-2			0-2-3		
P2	0-1	0-0	I-0; I-1; II-II-4			0-1; 1-2-2		
P3	0-1	0-0	I-1; I-1; II-II-4			0-1; 1-1; 1-2-2		
P4	0-I	0-0	I-1; I-1; II-II-4			0-1; 0-1; 1-3-1		
<i>Stephos balearensis</i>								
P1	0-0	0-1	0-0; 1-1; 1-2-2			0-2-3		
P2	0-1	0-0	I-1; I-1; II-II-4			0-1; 1-2-2		
P3	0-1	0-0	I-1; I-1; II-II-4			0-1; 0-1; 1-2-2		
P4	0-1	0-0	I-1; I-1; II-II-4			0-1; 0-1; 1-2-2		

organ. Right leg 4-segmented, ending in simple spiniform segment, distal part of which is as long as proximal part and forms right angle with it. Left leg with tumid, strongly developed, penultimate segment. Proximal part of segment bears 1 spiniform process on inner side, and another stronger one on distal outer side. Terminal segment bears 4 processes of approximately equal length and 1 stronger on inner side.

Etymology.—*baleariensis* = species found in the Balearic Islands.

Remarks.—There are only three genera included in the family Stephidae Sars, 1902: *Stephos* Sars, 1902; *Parastephos* Sars, 1902 et *Miostephos* Bowman, 1976. All the species are typically hyperbenthic, living just above the sea floor in shallow coastal waters or in submarine caves (Boxshall et al., 1990). Bowman (1976, p. 189) redefined this family and gave a key to differentiate these three genera.

The genus *Miostephos* includes two species (*M. cubrobex* Bowman, 1976 et *M. leamingtonensis* Yeatman, 1980) and differs from the next two genera by the 3-segmented urosome of the females and the asymmetrical leg 5 of males, with the left leg rudimentary. The genus *Parastephos* includes three species (*P. pallidus* Sars, 1902, *P. occatum* Damkaer, 1971 and *P. esterlyi* Fleminger, 1988) characterized by the 4-segmented urosome of the female and the asymmetric and complex leg 5 of the male, with the distal segment of the right leg armed with spines in the concave margin, and with forms similar to those of *Stephos*.

The genus *Stephos* includes 25 species and one juvenile form (Table 2). Two of these 25 species are doubtful: *S. simillimus* (description and figures are not clear in Brady 1918), *S. sinuatus* (Fosshagen 1970 has reidentified this species as *S. arcticus*). All the females of this genus, except females of three species (*S. lucayensis*, *S. margalefi* and, in minor degree, *S. tsuyazakiensis*), present a simple leg 5 characterized by a distal conical segment, more or less sharp and with spinules and microvillies. The general shape of the body, the complex structure of the genital segment of the females and the fifth leg of males and females found on Minorca suggest a possible relation with *S. lucayensis* or *S. margalefi*. Females from Minorca differ from the *S. lucayensis* on their symmetrical fifth leg, a hyaline sheath with less complex structure when carrying a spermatophore, and the spermatophore not so tubular as in *S. lucayensis*. Males differ on their complex asymmetrical 5th leg. *Stephos margalefi* is distinguished from the Minorca specimens by the following main characteristics: 1. segmentation of the cephalotorax: 4

Table 2.
List of species of the genus *Stephos* Sars, 1902 (Stephidae) with the localities where they have been reported

Species	Sex	Locality
<i>S. antarcticum</i> Wolfenden, 1908	f, m	Antarctic (Indian sector; Ross Sea?)
<i>S. arcticus</i> Sars, 1909	f, m	Arctic (Land's End Bay)
<i>S. balearensis</i> Carola and Razouls, 1995	f, m	Minorca (Balearic Islands)
<i>S. canariensis</i> Boxshall, Stock and Sanchez, 1990	f, m	Lanzarote (Canaries Islands)
<i>S. deichmannae</i> Fleminger, 1957	f, m	Gulf of Mexico
<i>S. exumensis</i> Fosshagen, 1970	f	Bahamas
<i>S. fultoni</i> T. Scott and A. Scott, 1898	f, m	Scotland (Clyde)
<i>S. gyrans</i> (Giesbrecht, 1892)	f, m	Naples
<i>S. kurilensis</i> Kos, 1972	f, m	Kuril Islands
<i>S. lamellatus</i> Sars, 1902	f, m	Norway
<i>S. longipes</i> Giesbrecht, 1902	f, m	Antartic Ocean
<i>S. lucayensis</i> Fosshagen, 1970	f, m	Bahamas
<i>S. maculosus</i> Andronov, 1974	f, m	West Indian Ocean
<i>S. margalefi</i> Riera et al., 1991	f, m	Majorca Island
<i>S. minor</i> T. Scott, 1892	f, m	Norway, Scotland
<i>S. morii</i> Greenwood, 1978	m	New Zealand (Moreton Bay)
<i>S. pacificus</i> Ohtsuka and Hiromi, 1987	f, m	Japan (Tanabe Bay)
<i>S. pentacanthos</i> Chen and Zhang, 1965	m	China Sea, Yellow Sea
<i>S. robustus</i> Ohtsuka and Hiromi, 1987	f, m	Japan (Tanabe Bay)
<i>S. rustadi</i> Strömngren, 1969	f, m	Norway (Lysefjorden)
<i>S. scottii</i> Sars, 1902	f, m	Scotland, Norway, Bay of Kiel?
<i>S. simillimus</i> Brady, 1918	f	Antarctic (off Macquarie Islands)
<i>S. sinuatus</i> Willey, 1923 (= <i>arcticus</i> ?)	f, m	Arctic (Hudson Bay)
<i>S. tropicus</i> Mori, 1942	f, m	Oropushakaru Island
<i>S. tsuyazakiensis</i> Tanaka, 1966	f, m	Japan (Kyushu)
<i>S. sp</i> Unterüberbacher, 1964	f	West of South Africa

segments plus the cephalosoma in *S. balearensis*, while 3 plus cephalosoma in *S. margalefi*. 2. no rostrum in *S. balearensis* while strong thick one, downturned and with no rostral filaments in *S. margalefi*. 3. different setation of A2, 1st maxilla, 2nd maxilla. 4. row of stout spinules on the basis of the maxilliped in *S. balearensis* but not in *S. margalefi*. 5. different setation of P3 (coxa with 1 seta in *S. balearensis* but 2 in *S. margalefi*). 6. different structure of P5 between *S. balearensis* and *S. margalefi* (both in females and males). All these differences have been observed by comparing our specimens with figures and text from the published paper of *Stephos margalefi* (Riera et al., 1991); it was not possible to obtain any specimens of the species type.

Pseudocyclopiidae T. Scott, 1894
Paracyclopia Fosshagen, 1985

Paracyclopia gitana new species
Figure 2A–N

Material Examined.—Two ♂♂.
HOLOTYPE. One ♂ collected on 19 June 1988 in Sa Gamba cave on Minorca (39°49'43"N, 4°12'20"E). Deposited in the Laboratoire Arago (Banyuls-sur-Mer, France. Cat. No. 2). Paratype: one ♂ collected at the same place than the holotype.

Description.—BODY. Total length 0.6 mm. Prosome about 2.4 times longer than urosome. Prosome: length/width about 2.2. Head: rounded (in dorsal and lateral view); rostrum strong and prominent in lateral view. Cephalosome and 1st pediger, and 4th and 5th pediger not fused (Fig. 2A–C).

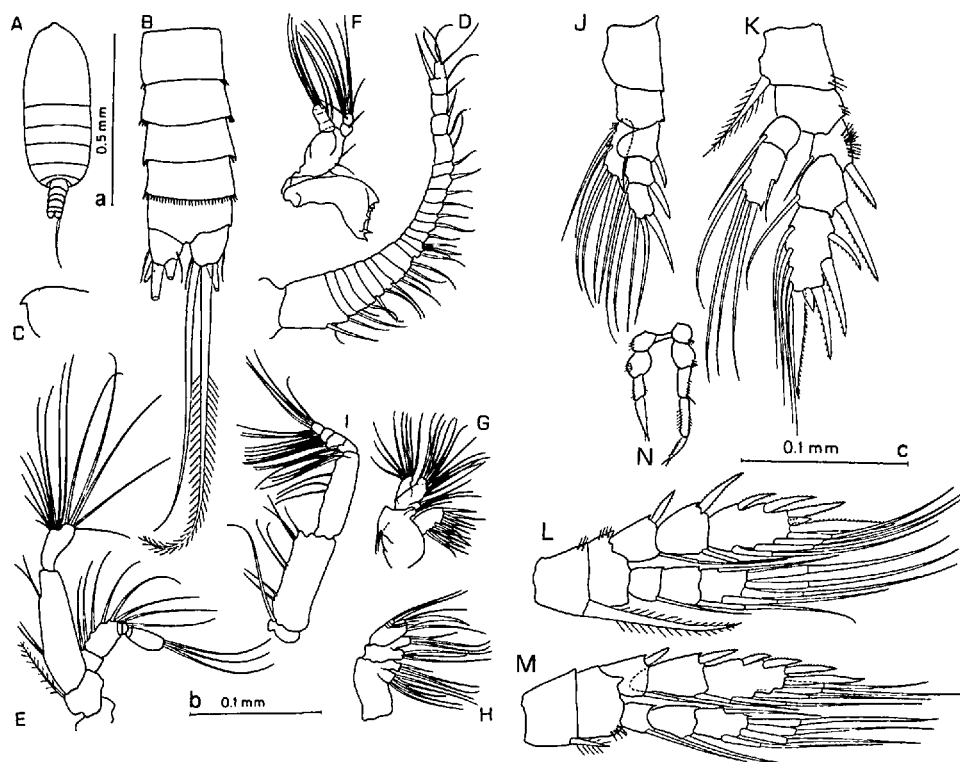


Figure 2. *Paracyclopia gitana*, new species. Male. (A: scale a; B–H: scale b). A. Dorsal view. B. Urosome, dorsal view. C. rostrum, lateral view. D. 1st antenna (antennule). E. 2nd antenna (antenna). F. Mandible. G. 1st maxilla (maxillule). H. 2nd maxilla. I. Maxilliped. J. 1st leg. K. 2nd leg. L. 3rd leg. M. 4th leg. N. 5th leg.

UROSOME. With 5 segments almost equal on length, each armed with fine spinules on lateral and ventral margins. Furca symmetrical armed with 3 strong distal setae and one fine seta on both outer and inner margins (Fig. 2B).

ANTENNULE. 22-segmented, extending up to posterior margin of prosome (Fig. 2D).

ANTENNA. Biramous, endopod longer than exopod ($=1.7$). Coxa and basis completely separated; basis armed with 1 seta. Endopod 2-segmented; segment 1 with 2 groups of 2 setae each, segment 2 with 9 setae on subapical lobe and 5 on apical lobe. Exopod 6-segmented; segment 1 with 1 seta, segment 2 with 5 setae, segment 3 and 4 with 1 seta each, segment 5 with no seta, and segment 6 with 3 distal setae (Fig. 2E).

MANDIBLE. Distal margin of gnathobase moderately expanded and with 4 cuspidate teeth and 2 exterior stronger. Palp biramous; basis with 3 inner setae. Endopod 2-segmented; proximal segment with 1 seta, distal segment with 8 setae. Exopod indistinctly 4-segmented; segments 1 to 3 each with 1 inner seta, segment 4 with 3 apical setae (Fig. 2F).

MAXILLULE. With precoxa produced into powerful endite bearing 9 stout spines and 4 setae. Coxa with 2 setae on endite; outer lobe (epipodite) represented by 2 setae. Basis fused to endopod, lacking outer setae; proximal endite bearing 2 setae; distal endite, fused with the endopod, armed with one group of 6 setae on inner

Table 3. List with the different genera and species of the family Pseudocyclopiidae T. Scott, 1894 and the localities where they have been reported (f: female, m: male)

Species	Sex	Locality
<i>Pseudocyclopia caudata</i> T. Scott, 1894	f	Scotland (Firth of Forth)
<i>P. crassicornis</i> T. Scott, 1892	f, m	Scotland (Firth of Forth), South Norway
<i>P. giesbrechti</i> Wolfenden, 1902	f, m	Scotland, Shetland Islands, South Norway
<i>P. insignis</i> Andronov, 1986	f, m	Mauritania
<i>P. minor</i> T. Scott, 1892	f, m	Scotland (Firth of Forth)
<i>P. muranoi</i> Ohtsuka, 1992	f, m	Japan (Tanabe Bay)
<i>P. stephoides</i> I. C. Thompson, 1895	f, m	Norway (Christiansund, Liverpool Bay) Mauritania
<i>Paracyclopia naessi</i> Fosshagen, 1985	f, m	Bermudes
<i>P. gitana</i> Carola and Razouls, 1995	m	Minorca (Balearic Islands)

margin. Free apical segment with 6 setae. Exopod 1-segmented, with 8 setae along distal and lateral margins (Fig. 2G).

MAXILLA. Small, comprising precoxa and coxa each armed with 2 endites. Basis with 1 endite. Endopod 3-segmented. Proximal and distal precoxal endites with 5 and 3 setae respectively. Both proximal and distal coxal endites with 3 setae. Endite of basis powerful, bearing 1 stout spine and 2 setae. Endopod segments 1 and 2 each with 1 seta, segment 3 with 2 setae (Fig. 2H).

MAXILLIPED. 7-segmented; first segment bearing 1 seta; second segment armed with hirsute lobe and 3 groups of setae: proximal and middle groups each of 2 setae, distal group with 3 setae. Third segment armed with 3 setae in middle, and 2 endopodal setae distal on margin; this segment also ornamented with row of stout spinules. Free endopod 4-segmented; first segment with 4 setae, segments 2 and 3 each with 3 inner setae; fourth segment with 3 inner setae and 4 apical (Fig. 2I).

Swimming legs 1–4 with 3-segmented exopods (Fig. 2J–M); leg 1 with 1-segmented endopod, leg 2 with 2-segmented endopod, legs 3 and 4 with 3-segmented endopods. Spine and seta formula in Table 1.

Exopod 1 of first leg with inner margin forming a lobe protruding laterally. Endopod with fine setules on inner margin. Coxa, basis and exopod 1 of leg 2 with fine short setules on outer margin. Coxa and basis of leg 3 ornamented with fine short setules on outer margin. Basis of leg 4 with short setules on inner distal margin.

Fifth leg uniramous; left leg with 5 segments, right leg with 4. All segments have small setules or spinules on inner or outer margins (Fig. 2N).

Other spinule or setule as in figures.

Etymology.—*gitana* = species found in the Gitano Cave (Balearic Islands).

Remarks.—The family Pseudocyclopiidae T. Scott, 1894, defined also by Sars, 1902 and Fosshagen and Iliffe, 1985, includes two genera: *Pseudocyclopia* T. Scott, 1892 and *Paracyclopia* Fosshagen, 1985 (Table 3). The fifth legs of the males are very different in these genera: P5 has a complex form in *Pseudocyclopia*, with a left basis swollen and a right distal article styliform, while in *Paracyclopia* it has a simple structure with five articles in the left leg and four in the right leg.

There is only one species within the genus *Paracyclopia*: *P. naessi* Fosshagen, 1985. The differences observed between this species and our specimens are summarized in Table 4. They are comparable with those observed among the different

Table 4. Morphological differences between *Paracyclopia naessi* Fosshagen, 1985 and *Paracyclopia gitana* new species

	<i>P. naessi</i>	<i>P. gitana</i>
total length	0.49 mm	0.6 mm
right A1	23-segmented	22-segmented
left A1	24-segmented	22-segmented
Ur 1	asymmetrical (on left side)	symmetrical
left P5	4-segmented	3-segmented
right P5	5-segmented	4-segmented
P3: exopod 1	2 external spines	1 external spine
P3: coxa	strong internal spine slightly longer than exopod 1	strong internal spine longer than exopod 2
P4: coxa	strong internal spine longer than endopod 1	internal spine shorter than basis

species of the genus *Pseudocyclopia*; for that reason we have created a new species within the genus *Paracyclopia* and not a new genus.

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